IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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In re Patent Application of

GATE — Atty. Ref.: SCS-540-388

Serial No. 07/052,111 — TC/A.U.: 3643

Filed: April 24, 1987 — Examiner: T. Collins

For: MISSILES AND CONTROL SYSTEMS THEREFOR

* * * * * * * * * * *

November 28, 2007

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

SUBMISSION OF PRIORITY DOCUMENTS

It is respectfully requested that this application be given the benefit of the foreign filing date under the provisions of 35 U.S.C. §119 of the following, a certified copy of which is submitted herewith:

Application No.	Country of Origin	Filed
8129316	UK	29 September 1981

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: ______________________
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THE PATENT OFFICE,
25 SOUTHAMPTON BUILDINGS,
LONDON. WC2A 1AY.

HANDLE AS U.S.

[redacted]

I, the undersigned, being an officer duly authorised in accordance with Section 62(3) of the Patents and Designs Act, 1907, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of documents as originally filed in connection with the Patent application identified therein.

I further certify that pursuant to Section 22(1) of the Patents Act, 1977, the Comptroller has ordered prohibition of publication of the said specification.

SECRET

WITNESS my hand this 22 day of OCTOBER 1982

C.O.C. 6 (S.S.)

CN-5000-560458-9122941-880-3-80

PATENTS ACT 1977

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[redacted]

PATENTS FORM NO. 1/77
(Rules 6, 16, 19)

The Comptroller
The Patent Office
25 Southampton Buildings
London WC2A 1AY

EFFECTIVE FORM

For fee stamp
See original
Form.

REQUEST FOR THE GRANT OF A PATENT

THE GRANT OF A PATENT IS REQUESTED BY THE UNDERSIGNED ON THE BASIS OF THE PRESENT APPLICATION

I Applicant's or Agent's Reference *(Please insert if available)* 20-1966D (NA/102)

II Title of Invention IMPROVEMENTS IN OR RELATING TO GUIDANCE SYSTEMS.

III Applicant or Applicants *(See note 2)*

Name (First or only applicant) British Aerospace Public Limited Company,

Address 100 Pall Mall,
London, SW1Y 5HR.

Nationality a British Company.

Name (of second applicant, if more than one) ....

Address ....

Nationality ....

IV Inventor *(See note 3)*

~~XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX~~
or
(b) A statement on Patents Form No. 7/77 ~~is~~ will be furnished

V Authorisation of Agent *(See note 4)* D. J. SAUL - GENERAL AUTHORISATION.

VI Address for Service *(See note 5)*

(Tel: Weybridge 45522, Ext. 541).

British Aerospace Public Limited Company,
Corporate Patents Department, (Bldg. T386),
Brooklands Road,
Weybridge, Surrey, KT13 OSJ.

VII Declaration of Priority *(See note 6)*

Country	Filing date	File number

VIII The Application claims an earlier date under Section 8(3), 12(6), 15(4) or 37(4) *(See note 7)*

Earlier application or patent number .... and filing date ....

C3559

IX Check List *(To be filled in by applicant or agent)*

A The application contains the following number of sheet(s)

1 Request ....1.......... Sheet(s)

2 Description ....6.......... Sheet(s)

3 Claim(s) ....–.......... Sheet(s)

4 Drawing(s) ....2.......... Sheet(s)

5 Abstract ....–.......... Sheet(s)

B The application as filed is accompanied by:-

1 Priority document ....–..........

2 Translation of priority document ....–

3 Request for Search ....–..........

4 Statement of Inventorship and Right to Grant ~~Apply~~ ....–..........

5 Separate Authorisation of ....–..........

X It is suggested that Figure No .... of the drawings (if any) should accompany the abstract when published

XI Signature *(See note 8)*

D. J. SAUL – CHARTERED PATENT AGENT

NOTES:

1 This form, when completed, should be brought or sent to the Patent Office together with the prescribed fee and two copies of the description of the invention.

2 The name, address and nationality of each applicant are to be stated in the spaces provided at III. Names of natural persons should be indicated in full. Bodies corporate should be designated by their corporate name. If there are more than two applicants the information concerning the third (and further) applicants should be given on a separate sheet.

3 Where the applicant or applicants is/are the sole inventor or the joint inventors, the declaration (a) to that effect at IV should be completed and the alternative statement (b) deleted. If however this is not the case the declaration (a) should be struck out and a statement will then be required to be filed upon Patents Form No.7/77.

4 If the applicant wishes to appoint an agent, his name and address of his place of business shall be indicated in the spaces available at V and VI; such indication will be considered to be an authorisation for the agent to prosecute the application up to grant of a patent and to service any patent so granted.

5 If no authorised agent is appointed an address for service in the United Kingdom to which all documents and notices may be sent must be stated at VI. It is recommended that a telephone number be provided if available.

6 The declaration of priority at VII should state the date of the previous filing and the country in which it was made and indicate the file number, if available.

7 When an application is made by virtue of section 8(3), 12(6), 15(4) or 37(4) the appropriate section should be identified at VIII and the number of the earlier application or any patent granted thereon identified.

8 If the request is signed by an agent, ~~An agent may sign only when previously authorised.~~ An express authorisation signed by the applicant(s) must be received by the Patent Office before the expiry of 3 months from the filing date.

9 Attention of applicants is drawn to the desirability of avoiding publication of inventions relating to any article, material or device intended or adapted for use in war (Official Secrets Acts, 1911 and 1920). In addition after an application for a patent has been filed at the Patent Office the comptroller will consider whether publication or communication of the invention should be prohibited or restricted under section 22 of the Act and will inform the applicant if such prohibition is necessary.

10 Applicants resident in the United Kingdom are also reminded that, under the provisions of section 23 applications may not be filed abroad without written permission or unless an application has been filed not less than six weeks previously in the United Kingdom for a patent for the same invention and no direction prohibiting publication or communication has been given or any such direction has been received.

29 SEP 1981
NA/102
DUPLICATE
NOT TO BE AMENDED.
8129316

'IMPROVEMENTS IN OR RELATING TO GUIDANCE SYSTEMS'

This invention relates to guidance systems and in particular to guidance systems with restricted fields of view.

Restriction of the fields of view of guidance systems sensors can give considerable advantages, for example in a guided missile when the target sensor is mounted in a position remote from the nose of the missile. Our co-pending Application No. 80 10353 refers to such an arrangement.

However, existing missile control systems are not able to maintain the target sight line sufficient for navigation, while the missile flies an intercept course if the sensor field of view is greatly restricted.

It is an aim of the present invention to provide means for the navigation of a missile to target interception, in a missile having a restricted field of view. Some loss of sight line may be tolerable.

According to the present invention there is provided means for translation of sensor commands into roll commands, said roll commands limited to ensure that the sight line is mtaintained sufficiently and additional steering commands conditioned by said roll commands.

The invention may be used when the responses to the navigation demands for desired lateral acceleration values (L_H and L_J) are approximately linear in axes not spinning about the missile but corresponding to it.

By way of example one embodiment of the invention will now be described with reference to the accompanying figures in which

Fig.1 illustrates typical fields of view;

Fig.2 shows a block diagram of embodiment of the invention;

Fig.3 shows a possible implementation of two lateral autopilots used to improve roll rate capability.

With reference to Fig.1 LJn and LHn are the demands for LJ and LH (Fig.2) derived for a standard navigation law for example Acceleration Vectored Navigation (described in Guided Eapon Control Systems by P. Garnell and D.J. East (Pergamon Press 1977) Section 9.9. The invention modifies these demands to provide demands that match LJn and LHn subject to the constraints imposed by the limited field of view.

Block 1 converts the cartesian components LJn and LHn to polar coordinate form and gives outputs proportional to angle

$$= \begin{cases} \arg\,(LJn,\ LHn) & -\pi < \phi < \pi \\ 0 & \text{otherwise} \end{cases}$$

and amplitude λ

$$\lambda = \sqrt{(LJn^2 + LHn^2)}$$

Block 2 gives an absolute value and 3 is a threshold detector. If the threshold value of 3 is exceeded logic switch 4 switches from the current value to the previous computed value through 5. This arrangement reduces any tendency towards violent manoeuvres that may be caused by noise or small perturbations. A limiter 6 has limits controlled by the logical switch 7

which switches from multiplied by gain K at 9 for a false (zero) input to max for a true input. The output from the limiter 6 is multiplied by a gain K_p 8 to give the demand Pd to a roll rate or roll control system. Filtering of Pd using standard techniques may be required.

The λ output from 1 is also an input to threshold detector 10 from which a 0 or 1 logic output goes to the OR gate 12. The other input to 12 is derived from threshold detector 11. The input to 11 from 13 is an indication of the target sight line separation from the missile axis for example $\sqrt{LH^2 + LJ^2}$ and is calculated by 13. The output from 12 is used to operate the logic switches 14 and 15 as well as 7. The operation of the lower limiter 16 of LJn is set by the output of 15. The upper limiter of LJn is 17 and the output from 17 is the demand in one axis.

A computation at 18 using the outputs ϕd from 6 and LJd from 17 gives L'Hd

where

$$L'Hd = LJd \tan \phi d$$

The error between L'Hd and LHn is the input to the limiter 19 controlled by switch 14. The output from 19 is added to LHn and is the demand for the other axis LHd.

The ϕ output from 1 gives a measure of the angle between the raw demanded look angle direction and the current direction of the field of view slit. This is used after some modification to provide an error signal to drive the missile roll demands. Using the raw look angle demands instead of the measured look angle to drive the rolling motion of the missile has the advantage of providing the missile with advanced warning of the intended rolling motion so the missile tends to roll in the right direction long before the measured look angle makes this necessary. In the presence of noise and roll limiting by 6 the demands Pd can change sign rapidly causing time to be lost before the missile is demanded to roll in the correct direction for instance if the demands are near $\pm \pi$ rad. The invention includes 2, 3, 4, and 5 to reduce this by keeping the demand nearly fixed when the demands

radians &
are near $\pm \pi$. the limiter 6 is included so that the missile does not roll fast enough to cause an out of plane or underdamped response from a standard autopilot that is responding to LHd and LJd.

The arrangement of 1, 10, 11, 13 and 12 is used to indicate when the demands and look angle are small enough to make the missile fly momentarily within the restricted field of view A of figure 1.The output from 12 Bd is false (zero) in this case.

When Bd equals zero the rolling of the missile has little consistent effect on the pitching of the missile and the limited lateral look angle capability of the missile is used to reduced the roll control demands in proportion to λ as indicated by 9 and 7. A similar effect could be achieved by changing the value of the gain Kp 8 instead of the limit. 18 is used to give a demand for LH that matches the roll demand ϕd and thus keeps the target near the LJ axis in figure 2..

Normally the limits in 19 are set to zero when Bd = 1 and opened up when Bd = 0 so that the lateral look angle capability of the missile can be used in this case. Similarly for the control of the limits of 16 by 15. The limit 17 is not essential but may be included to slightly extend the missile tracking capability in cases when the field of view is needed.

Preferably the invention would be implemented using microprocessors and take the form of a small computer. One example of an autopilot suitable for use with this invention is given in Garnell and East section 6.10. for roll control.

Two identical autopilots may be used one for pitch and one for yaw for example Garnell and East section 6.3.

The roll rate capability of the missile may be improved by advancing the demands in the direction of rotation as a function of roll rate to compensate for the lag produced by the actuator. Fig 3 shows a possible implementation.

Those skilled in the art will recognise that the priorities of roll signals and conditioned steering signals may be varied to advantage for other applications.

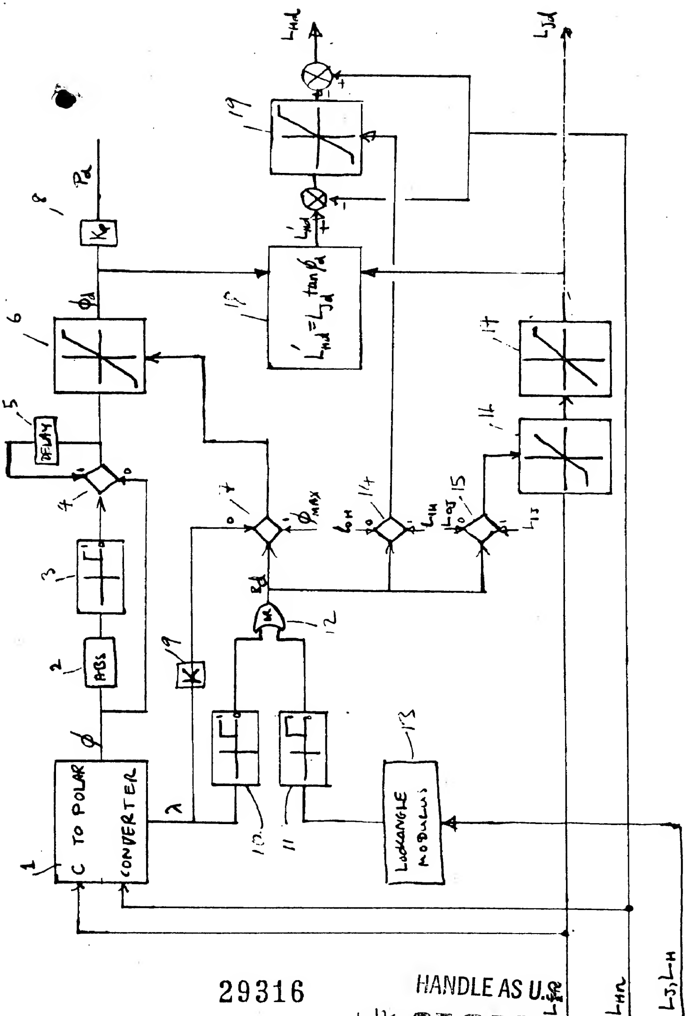

Figure 1

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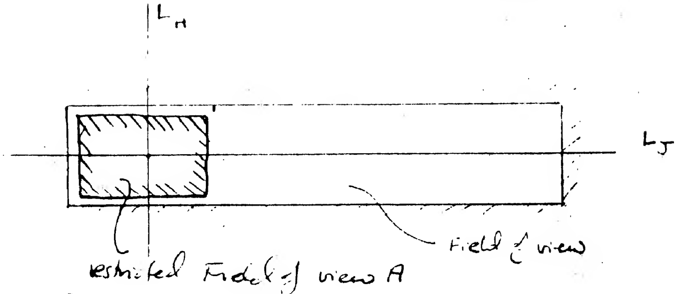

Figure 2

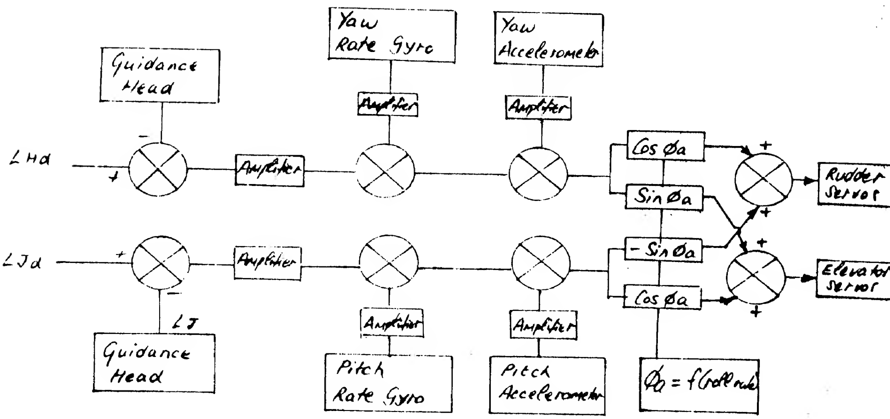

figure 3